

Fieldwork

Using the *SeaBED AUV* for Geologic and Benthic-Habitat Studies of the Sea Floor

By Page Valentine

Scientists from the U.S. Geological Survey (USGS), the National Oceanic and Atmospheric Administration (NOAA), and the Woods Hole Oceanographic Institution (WHOI) participated in a March cruise to the Stellwagen Bank National Marine Sanctuary off Boston, MA, to test an autonomous undersea vehicle (AUV) developed by **Hanumant Singh** and his colleagues at WHOI's Deep Submergence Laboratory.

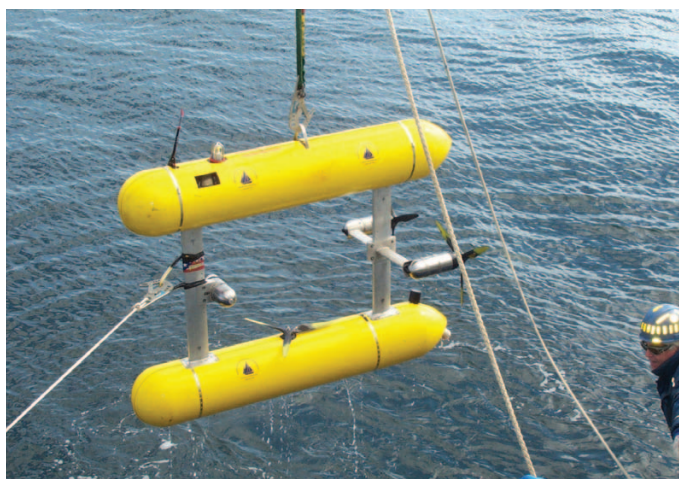
The AUV is constructed of two horizontal bodies configured one above the other, connected by struts, and weighs approximately 400 lb in air. The *SeaBED AUV* is designed to precisely navigate survey tracks at altitudes as low as 2.5 m above the sea floor. Propellers oriented in different planes allow the AUV to maintain course and altitude while avoiding obstacles. On launch, the vehicle propels itself vertically downward until its navigation system locks onto the seabed at 30-m altitude and it can begin its programmed survey. It can acquire digital color photographs, sidescan-sonar imagery, high-resolution swath topography, and current-meter data. In its present configuration, the AUV can remain submerged for as long as 3 hours (to be increased to 8 hours in the near future) and can acquire 1,200 photographs per hour, with varying degrees of overlap as determined by vehicle speed (0.5-2 knots). Processing of the images provides stunning views of the sea floor.

The *SeaBED AUV* is preprogrammed to perform various functions during its dive. Vehicle speed, altitude, photograph timing, and use of camera and sidescan sonar all can be varied during a single deployment. For example, the AUV can acquire photographs (2.5-m altitude) along separate

(*Sea Floor continued on page 2*)



Digital photograph of the sea floor acquired by the SeaBED AUV. Mobile coarse sand with storm-generated ripples surrounds a small (about 3/4 m long) boulder encrusted with finger sponges, anemones, hydrozoa, and other epifauna. Small flounder lies on sand to left of boulder. Image shows an area of the sea floor measuring 1.95 by 1.55 m (3 m²).



Retrieval of the SeaBED AUV by the research vessel Oceanus in Stellwagen Bank National Marine Sanctuary. Electronics and flotation are in the upper body; digital camera, sidescan sonar, scanning fathometer, current meter, and batteries are in the lower body. Note placement of the twin propulsion units on the rear strut and the single, vertically oriented propulsion unit on top of the lower body.

Sound Waves

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SOUND WAVES (WITH ADDITIONAL LINKS)
IS AVAILABLE ONLINE AT URL
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Submission Guidelines

Deadline: The deadline for news items and publication lists for the July 2003 issue of *Sound Waves* is Thursday, June 12.

Publications: When new publications or products are released, please notify the editor with a full reference and a bulleted summary or description.

Images: Please submit all images at publication size (column, 2-column, or page width). Resolution of 200 to 300 dpi (dots per inch) is best. Adobe Illustrator® files or EPS files work well with vector files (such as graphs or diagrams). TIFF and JPEG files work well with raster files (photographs or rasterized vector files).

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Can't find the answer to your question on the Web? Call **1-888-ASK-USGS**

Want to e-mail your question to the USGS? Send it to this address: ask@usgs.gov

Fieldwork, continued

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transects, or along overlapping transects to make a mosaic of the seabed, and it can perform a sidescan-sonar survey (10-m altitude). Maximum water depth for the AUV at present is 2,000 m.

The cruise to the Stellwagen Bank National Marine Sanctuary aboard WHOI's research vessel *Oceanus* was designed to test the AUV in an area that has been mapped by using multibeam swath-sonar imagery and extensive groundtruthing with video and photographic imagery and geologic and biologic sampling. The vehicle successfully conducted several long (3 km) photographic surveys across various habitats and major topographic features; it also performed a tight grid survey of a boulder ridge to obtain a mosaic of the seabed. The lines of the grid survey were spaced 1.4 m apart to ensure adequate

overlap of digital photographs. In addition, the *SeaBED AUV* performed a survey of the sea floor in tandem with the *REMUS AUV* (deployed from a different ship), which surveyed the water column by using a CTD (conductivity-temperature-depth sensor) and a video plankton recorder.

The *SeaBED AUV* proved to be a valuable tool for acquiring sea-floor data for a range of purposes, from the making of detailed mosaics of specific features to conducting long photographic and sidescan-sonar transects for describing surficial geology and benthic habitats. Cruise participants included chief scientist **Hanumant Singh** (WHOI), **Page Valentine** and **Soupy Alexander** (USGS), **James Lindholm** (Stellwagen Bank National Marine Sanctuary), and **Ryan Eustice**, **Oscar Pizzaro**, **Ali Can**, and **Ken Foote** (WHOI).✻

Integrated Science in the Suwannee River Estuary

By Ellen Raabe

At the end of Florida's County Road 349, beyond the reach of cellular telephones, lies the Suwannee River estuary. Unlike familiar embayment estuaries, a shallow limestone shelf and oyster reefs create the low-energy environment of

this unique estuary. The Suwannee River is one of the least disturbed rivers in the Southeast United States. The estuary and surrounding marshes are nursery, feeding grounds, and refuge to countless fish, crus-

(*Suwannee River continued on page 3*)



(Left to right) **Gary L. Hill**, **Randy Edwards**, and **Carole McIvor** (USGS, St. Petersburg, FL) return from collecting fish in the Suwannee River estuary. Photograph by **Ellen Raabe**.

Fieldwork, continued

(Suwannee River continued from page 2)

taceans, and invertebrate species; they are also home to the threatened gulf sturgeon (*Acipenser oxyrinchus desotoi*).

Researchers from the U.S. Geological Survey (USGS)'s Florida Integrated Science Centers (FISC) are conducting a project to identify and map essential fish habitat in the shallow nearshore of the Suwannee River estuary. The project combines mapping with multispectral imagery, hydrologic modeling, and an evaluation of fish assemblages in the tidal creeks.

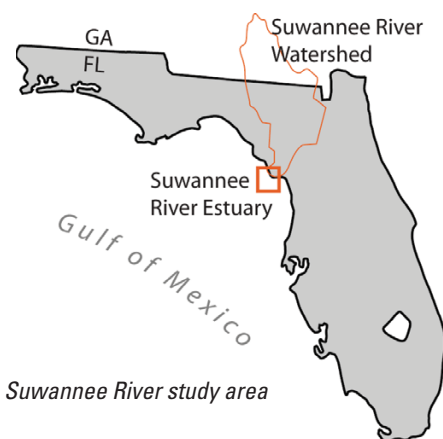
Field teams set out in thick fog to collect fish samples and groundtruth data during March 2003. A USGS team from Gainesville, FL, including **George Dennis**, **Bob Lewis**, and **Steve Walsh**, joined the USGS team from St. Petersburg, FL, **Carole McIvor**, **Randy Edwards**, **Ellen Raabe**, **Keith Ludwig**, **Gary L. Hill**, and **Chad Stout** (USGS contract employee through ETI Professionals). The USGS teams pooled resources with U.S. Fish and Wildlife Service biologist **Steve Barlow** for the field effort. Seine nets, throw traps, and rivulet nets were deployed to catch and identify fish species that use the creeks, seagrass beds, and marsh surface



(Left to right) **Carole McIvor** (USGS, St. Petersburg, FL) works with **George Dennis** and **Bob Lewis** (USGS, Gainesville, FL) to locate rivulets draining the surface of the marsh at low tide. Rivulet nets are set up to capture fish that use the surface of the marsh for feeding and refuge during high tide. As the water ebbs during low tide, the fish are trapped in the net. Photograph by **Ellen Raabe**.

throughout the tidal cycle. Ground positions were annotated to identify substrate, water depth, submerged aquatic vegetation, and emergent vegetation. Braving fog and thick marsh sediment, airboat operator

Bob Lewis mobilized night crews to collect the rivulet nets at low tide. The team plans to have a map of essential habitats and geomorphic and benthic conditions this fiscal year. ❁



Suwannee River study area

(Left to right) **Chad Stout** (ETI), **Randy Edwards**, and **Keith Ludwig** (USGS, St. Petersburg, FL) empty fish from a seine net to a collection trap. Fish from the tidal creeks are identified, measured, counted, and released. They are typically small fry, 0.5 to 1.5 inches long, and might include juvenile spot, flounder, and baby blue crabs. At this site on Bumblebee Creek, a 1-ft-long stingray was also trapped in the seine net. Photograph by **Ellen Raabe**.



Mapping Ecologically Sensitive Islands in the Bering Sea

By A.C. Brown



The Pribilof Islands provide breeding grounds for more than two-thirds of the world's northern fur seals. Photographs courtesy of NOAA's Office of Response and Restoration.

The U.S. Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA)'s Office of Response and Restoration have recently completed a set of environmentally important maps of the Pribilof Islands, Alaska. Begun in 2000, the cooperative project concluded in March 2003 with the final delivery of map products to be used in NOAA's ongoing remediation of contaminated sites in the Pribilof Islands. The new map products consist of both digital data sets and paper products, including the first USGS topographic-quadrangle maps of the islands at a scale of 1:25,000

and a set of digital orthophotoquads based on aerial photographs taken in 1993. In addition to supporting remediation activities, the new map products will assist researchers in classifying vegetation, analyzing shoreline and land-use changes, and identifying and protecting sensitive habitats for migratory birds and marine mammals.

The Pribilof Islands are in the Bering Sea, approximately 770 mi west-southwest of Anchorage and 250 mi north of the Aleutian Islands. Approximately 3 million seabirds nest on the islands, and nearly 1 million northern fur seals—about 70 per-

cent of the world's northern-fur-seal population—migrate there each year to breed. Other animals on the islands include arctic foxes and herds of reindeer.

The Pribilof Islands were an attractive part of the United States' 1867 purchase of Alaska from Russia, in part because of the significant economic trade activity of northern-fur-seal pelts that were available in abundance on the islands. The islands have been managed by various Federal agencies, most recently by NOAA's National Marine Fisheries Service.

(Bering Sea continued on page 5)

(Bering Sea continued from page 4)

Within the volcanic Pribilof Islands archipelago, the tiny islands of St. George and St. Paul (approximately 35 and 44 mi², respectively) are the only two with human inhabitants; collectively, they are home to the world's largest community of Aleut people. Brought to the islands in the late 1700s to harvest seals for Russian fur hunters, Aleuts have made their home there for more than 200 years, providing labor for both Russian and United States interests in the fur-seal trade during most of that time.

In 1971, the Alaska Native Claims Settlement Act provided for the transfer of 40 million acres of Alaska's lands back to Alaskan Natives who had occupied and used the land for generations. In 1983, most Federally controlled lands on the Pribilof Islands were designated for transfer to the Aleuts. Conditions for property transfer called for the United States to restore the islands' environmental integrity by removing all debris and contamination associated with government management activities.

NOAA has been charged with cleanup activities on the Pribilof Islands. Although several thousand tons of debris were successfully removed from the islands by the year 2000, residual debris sites and areas of soil contamination remain the focus of present cleanup activities at more than 40 sites on St. George and St. Paul. Restoration efforts on the Pribilofs require hundreds of soil and ground-water samples to evaluate the vertical and horizontal extent of con-

tamination. The locations of these samples, together with those of existing debris fields, cultural features, and natural resources, need to be accurately mapped and recorded to help NOAA successfully track progress on its rehabilitation efforts. Such mapping requires accurate base maps, which did not exist for the islands before the year 2000.

To remedy this lack, the Pribilof Islands Restoration Project (<http://response.restoration.noaa.gov/pribilof/linkpage.html>) initiated a joint project by NOAA and the USGS to develop a suite of standard map products to combine with project-related data and historical information. The resulting integrated, multimedia geographic-information system (GIS) will be used by participating agencies and groups in cleanup activities, resource management, environmental stewardship, and scientific research on the islands.

Producing contaminated-site maps is a critical step in the process of identifying environmentally hazardous areas in relation to such sensitive wildlife areas as seal-breeding colonies, areas of seal distribution and movement, and areas that could be sensitive to the environmental effects of any future contaminant spillage. Additionally, information on fur-seal abundance can be linked to specific geographic locations for use in studying seal-population dynamics and prioritizing future protective measures. These new base maps will also assist researchers in classifying vegetation,

analyzing shoreline areas, and classifying land-use changes over time.

To make these map products more useful and meaningful to the Alaskan Native population, the decision was made to ask for local guidance in determining place names for geographic features. A concerted effort was made by the local residents to identify the original Aleut names for various geographic features on both islands. This local contribution helped to create a more realistic product that acknowledges the historical and linguistic importance of the Aleut language and will help preserve it. The Alaska Historical Commission and the U.S. Board on Geographic Names concurred on the significance of this innovative approach and endorsed use of the local names that were provided to the USGS for incorporation into the final map products. This approval allowed for the labeling of geographic features on the maps to be in both English and Aleut.

The new map products, together with the wide variety of digital data accumulated during the project, will be used to restore the environmental integrity of the islands and to identify and protect sensitive habitats for migratory birds and marine mammals. The data are also being shared with Native communities on the islands for land-use purposes, economic-development analysis, education, and natural-resource management. ❁

Outreach

Students Can Track Florida's Manatees via the Journey North Web Site

By Cathy Beck

Scientists from the U.S. Geological Survey (USGS)'s Center for Aquatic Resource Studies in Gainesville, FL, are providing manatee life-history and radio-tracking data to Journey North, an educational Web site at URL <http://www.learner.org/jnorth/>.

The scientists are part of the Sirenia Project, named for the scientific order that includes manatees and dugongs, also known as sea cows. (Information

about the project is available at URL http://www.fcsc.usgs.gov/Manatees/Manatee_Sirenia_Project/manatee-sirenia_project.html.) They conduct long-term, detailed studies on the life history, population dynamics, and ecological requirements of the endangered Florida manatee (*Trichechus manatus*). Project biologist **Cathy Beck** has played a key role in providing manatee data to the Journey North Web site.

Journey North is used in more than 9,000 schools in North America as a model for improving math and science education for K-12 students. It is supported by the Annenberg Foundation and the Corporation for Public Broadcasting. Through Journey North, students participate in tracking the migration of monarch butterflies, hummingbirds, manatees, and other mammals, the budding of plants,

(Journey North continued on page 6)

(Journey North continued from page 5)

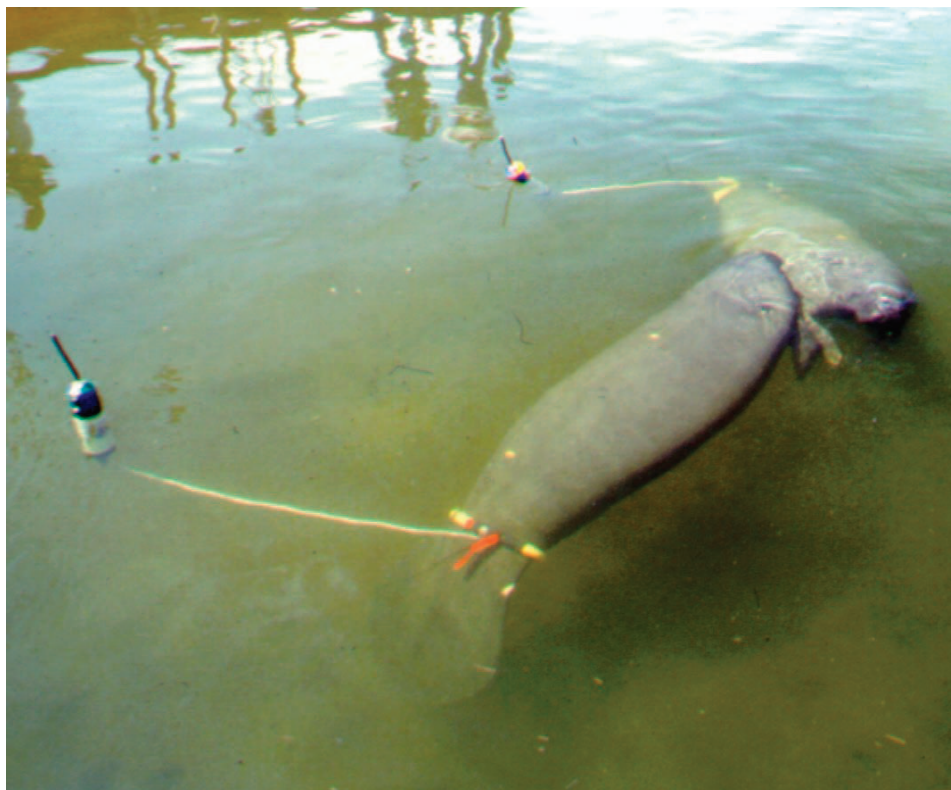
and changes in the local environment, all via the Internet. For the past 6 years, the USGS' Sirenia Project has participated by providing data on movements of individual radio-tagged manatees. The project also provides photographs and biological information on the species.

Each week, coordinates of selected radio-tagged manatees are submitted to Journey North for posting on the Web site. Students can then plot new manatee locations, answer questions about where the animals have moved, and hypothesize about why certain animals have or have not moved. The students are also provided with life-history information about the manatees; for example, they are told when a calf is born to one of the tagged manatees and how the birth might affect her movement patterns. The students are learning how to locate sites on a map by using latitude and longitude, how to read depth contours, and how to relate an animal's response to weather patterns, food resources, changes in freshwater availability, and other factors. The feedback the USGS receives from teachers and students demonstrates how much thought and discussion ensue in the classroom!

The Web site is a great resource for educators, as well as for parents with children especially interested in animals and migratory behavior. The site is active from January through April. Archives of data, maps, photos, and related materials remain on the site year-round.

How Manatees Are Tagged for Radio Tracking

To capture manatees for tagging, USGS scientists use a net deployed from shore or a boat. For shore-based captures, nets are partially set at a selected site where a manatee is expected to appear. The depth of the net must exceed the depth of the water, and leadlines are onshore. Thus, a partial bag is really what is in the water, with a line on the floatlines so that the crew can pull it in when the "right" manatee swims into the "bag." For an adult manatee, a strong, experienced crew of 8 to 10 people or more, waiting quietly on shore, is needed. Boat captures are preferred for recapturing tagged manatees (for medical assessment, for example), for capturing injured



Two radio-tagged manatees socializing. The tags, buoyant cylinders tethered to belts around the manatees' tails, contain electronic devices for tracking the animals. See text for details.

manatees, and for capturing manatees in areas without an adjacent smooth beach for safely hauling the manatee ashore. For boat captures, the chosen manatee is spotted, and a net is carefully set around it, then pulled. The capture boat has an open stern that allows the boat crew to pull the net and manatee directly on board. The stern actually sinks a bit, soaking the crew, as the manatee is pulled aboard. Because there is less working room on board the boat than on the shore, boat captures require the strongest members of the capture crew. When a manatee is captured by either method, every member of the capture team has a job. The goal is to assess, tag, and release as quickly as possible.

The tag assembly consists of a buoyant cylinder (seen floating behind the manatees in the photograph) containing a very high frequency (VHF) radio-wave transmitter that allows researchers to locate the manatees while in the field. Enclosed in the tag housing is an ultra-high-frequency (UHF) transmitter, also referred to as a platform transmitter terminal, or PTT. The PTT al-

lows the manatees to be tracked remotely by the Service Argos monitored satellite system. A few of the tags also include a global-positioning-system (GPS) data logger.

The cylinder is connected to a flexible tether attached to a padded belt that fits around the base of the manatee's tail. A sonic beacon is built into the belt to enable manatees that have lost the transmitter to be relocated and identified. The "life" of the tag depends on many factors. Battery life is about 2 years for the VHF transmitter and about 6 months for the PTT. The tether has a built-in weak link designed to break free from the manatee if the tag becomes entangled (in mangrove roots, for example, or under dock pilings). Corrodible connections of nuts and bolts are purposely used in the belt to allow it to eventually fall off in the event it cannot be removed manually from the manatee. Tags are constructed in the USGS' Gainesville office. The development of the tag design and technical and practical improvements made over the years can be credited to **Jim Reid**, a biologist with the Sirenia Project. ☼

St. Petersburg Mayor Visits USGS Research Facility

By Dennis Krohn

Mayor Rick Baker of St. Petersburg, FL, visited the U.S. Geological Survey (USGS)'s Center for Coastal and Watershed Studies on April 10. The mayor and his staff had extensive discussions with center chief **Lisa Robbins** and operations manager **Terry Kelley** on plans for constructing a third building on the campus. Two members of his economic-development staff accompanied the mayor: **Ron Barton**, director, and **Teresa Brydon**, development coordinator. The mayor took a tour of the old Studebaker building and, as a keen observer, noted the change in flooring required to make the old showroom floor suitable for use in an office

environment. The mayor met with **Kim Yates** to discuss Tampa Bay integrated science issues and **Abby Sallenger** to discuss coastal-change-hazards issues. The tour finished with a description of the new lab facilities on the second floor of the Getting building and a walkthrough of the shop area on the first floor. The mayor's only complaint was that he was too tall to stand upright in the *SHARQ Express* houseboat, designed to support benthic-community-metabolism experiments. ☼

⇒ **Mayor Rick Baker** bends his head slightly to discuss the Tampa Bay Study with **Kim Yates** aboard the *SHARQ Express* houseboat.



⇒ **Lisa Robbins** discusses building-expansion issues with the mayor's staff while the mayor tours the *SHARQ Express*. From left to right are **Ron Barton**, City of St. Petersburg, **Lisa Robbins**, **Terry Kelley**, **Dennis Krohn** (USGS), and **Teresa Brydon**, City of St. Petersburg.



⇒ The mayor finishes his tour with an inspection of the laboratory facilities in the Getting building, the second building on the USGS St. Petersburg campus. From left to right are **Lisa Robbins**, **Teresa Brydon**, **Ron Barton**, **Mayor Rick Baker**, and **Molly McLaughlin**, lab manager for the USGS in St. Petersburg.



Local Interest in a New USGS Map Poster for the Town of Falmouth

By Debbie Hutchinson and Jeff Williams

Earlier this year, the town of Falmouth, MA, inquired about recent (circa late 1960s and 1970s) topographic maps of Falmouth, including Woods Hole and five other villages. The query eventually made its way to the U.S. Geological Survey (USGS)'s Woods Hole Field Center. Those topo sheets, once pioneer sheets for being published as metric maps (1:25,000 scale), are now 35 years old and sadly out of date, considering the intense development of Cape Cod in the 1980s and 1990s. As a public service, the USGS has often given the library copies of the topo sheets of the

town. This year, in an effort to upgrade the mapping product, we generated a poster showing digital images of the topo sheets side-by-side with newer aerial photography available through MassGIS, the Massachusetts Office of Geographic and Environmental Information. **Elizabeth Pendleton**, recently hired to work with **Jeff Williams** and **Rob Thieler** on coastal sea-level-rise vulnerability, produced the poster, which has been a huge hit. The detail in the aerial photography, in comparison with the older topographic base map, provides a wealth of information (and topics) for investigat-

ing growth and change in the town of Falmouth. To date, copies of the new poster have been presented (or distributed) to the Falmouth Public Library, the Falmouth Selectmen, each of the schools in town, the Falmouth Conservation Commission, and the Waquoit Bay National Estuarine Research Reserve, among others. Although requests for personal copies of the poster have started, our policy is to generate the poster only for public use. A copy is displayed outside the team chief scientist's office in Woods Hole. A hearty thanks to **Elizabeth Pendleton** for a map well done! ☼

Teachers from the Institute for Science Instruction and Study Visit USGS in Woods Hole

By Bill Winters

Susan Hageman, Program Director of the Institute for Science Instruction and Study (ISIS), and 16 high-school and middle-school science teachers from throughout Connecticut visited the U.S. Geological Survey (USGS)'s Woods Hole Field Center (WHFC) on March 15. The teachers are participants in ISIS, established in 1985, which is an intense, 2-year interdisciplinary program aimed at advanced-degree science teachers interested in bringing new discoveries, technologies, and ideas into the classroom. This was the third ISIS group to visit Woods Hole since 1995. The teachers were given a tour of the WHFC facility, including a visit to GHASTLI (Gas Hydrate And Sediment Test Laboratory Instrument) and other instrumentation in the Geotechnical Laboratory that is used by **Bill Winters**, **Bill Waite**, **Dave Mason**, and **Brandon Dugan** (a recent postdoctoral fellow from Penn State). The teachers were given a presentation on gas hydrates, including information about USGS field and laboratory programs. They also viewed video clips of a force-12 storm weathered by the Ocean Drilling Program's drill ship *JOIDES Resolution* and the giant-piston-coring program conducted aboard the French Polar Institute's research vessel *Marion Dufresne* during July 2002 in



Susan Hageman (top right), Program Director of the Institute for Science Instruction and Study (ISIS), and 16 high-school and middle-school science teachers from Connecticut visited the USGS' Woods Hole Field Center to learn about gas hydrates.

the Gulf of Mexico (see September 2002 *Sound Waves*). The teachers were given numerous fact sheets, teacher's packets, and Web-related handouts provided by **Nancy Soderberg** and **Joanne Sedlock**, and enjoyed learning about ongoing work

performed by the WHFC, as depicted in hallway posters. Because each of the 16 teachers instructs 100 to 130 students per day, the information gained by the Woods Hole visit potentially reached more than 1,600 students the following week. ❁

USGS Landsat Images to Appear in the Textbook *Understanding Earth*

By Dennis Krohn



Two Landsat images from the U.S. Geological Survey (USGS)'s Gulf of Mexico Integrated Science Web site have been selected for use in a revised textbook, the fourth edition of *Understanding Earth*, by **Frank Press**, **Raymond Siever**, **John Grotzinger**, and **Thomas H. Jordan**. **Elyse Rieder**, a photo researcher working for the publisher, W.H. Freeman, requested permission to use images of the Atchafalaya River Delta and the Mississippi River Delta in the book. Thanks to the legwork

of **Chris Cretini** (National Wetlands Research Center, Lafayette, LA) and **Renee Koenig** (Center for Coastal and Watershed Studies, St. Petersburg, FL), permissions were obtained, and the USGS provided high-resolution files suitable for 1/4-page figures. Publication is expected to run about 25,000 copies, which will be distributed worldwide. For a preview of the textbook (due to be published in July 2003), visit URL <http://bcs.whfreeman.com/understandingearth/>. The two images contributed by the USGS (and more) can be viewed at URL <http://gulfsci.usgs.gov/missriv/aerials.html>. ❁

USGS Scientists in Woods Hole, MA, Give “Telelecture” to Students in Louisiana

By Erika Hammar-Klose

On March 25, 2003, **Erika Hammar-Klose** and **Elizabeth Pendleton** of the U.S. Geological Survey (USGS)’s Woods Hole Field Center (WHFC) gave a “telelecture” to a seminar class at Louisiana State University from the WHFC Conference Room. The class, Environmental Hazards Analysis, is taught by Professor **John Pine** of the university’s Environmental Studies Department. **Erika** and **Elizabeth** talked about the coastal-vulnerability-index (CVI) studies completed by scientists at the WHFC along the Gulf of Mexico coast and within Gulf Islands National Seashore. The CVI studies investigate the potential impacts of sea-level rise



Erika Hammar-Klose (right) and **Elizabeth Pendleton** give a “telelecture” to a seminar class at Louisiana State University from the WHFC Conference Room.

on U.S. coasts and within National Park Service coastal parks. The presentation included discussions on the problem of sea-

level rise, CVI methodology, data sources included in the CVI and reasons for their inclusion, and final results of the study.✿

USGS Helps Celebrate Early Earth Day in Florida

By Dennis Krohn

Officially, Earth Day falls on April 22, but events around the country were held on various dates throughout the month. On April 11, the U.S. Geological Survey (USGS) joined forces with Tampa Bay Water to help celebrate Earth Day early at McMullen Booth Elementary School in Clearwater, FL. **Kathy Krohn**, a volunteer for the USGS Center for Coastal and Watershed Studies in St. Petersburg, improvised a hands-on rock display for the 700 students at the school. (A display entitled “Marshes as Sponges,” originally intended for the event, was not used because of 20-knot gusty winds from the northwest.) Tampa Bay Water, a neighbor of the school, was one of the dozen other organizations to participate in the event.



Kathy Krohn (right) and **Laurie McConnell** hold up the USGS banner at an early Earth Day celebration on April 11 at McMullen Booth Elementary School. **Robert McConnell** (Tampa Bay Water) is at left.

Tampa Bay Water is a government agency recently created by agreement among local jurisdictions to provide wholesale water to

the communities in the Tampa Bay region (for more information, see URL <http://www.tampabaywater.org/>).✿

USGS Landsat Image Featured at Great Explorations Museum

By Dennis Krohn

A Landsat image of Tampa Bay, produced at the U.S. Geological Survey (USGS)’s Center for Coastal and Watershed Studies, was selected for a children’s exhibit at the newly upgraded Great Explorations museum in St. Petersburg, FL. The 15-year-old museum recently moved to Sunken Gardens, a historic tourist attraction that was purchased by the city of St. Petersburg in 1999. As part of its reno-

vations, the city decided to include Great Explorations in the restored exhibit space. Hands On! Inc., a local exhibit firm that helped found Great Explorations, designed all-new exhibits for the renovated museum. They selected the poster image of Tampa Bay as the focus for an “I Spy St. Pete!” exhibit. The 1991 Landsat image, enhanced by **Ellen Raabe**, shows mangroves and healthy vegetation as green,

agricultural fields and low-vegetation growth as pink, and water as blue. The exhibit designers worked these colors—pink, blue, and green—into a story scene, a collection of photographs and old toys and knickknacks that children can use to make up stories. The USGS hopes to continue working with Hands On! Inc. to produce a more technical exhibit related to water in the mezzanine area of the museum.✿

Frank Manheim Gives Lectures in Ireland and Sweden, Gathers Information on New European Offshore Geological Programs

By Frank Manheim

U.S. Geological Survey (USGS) emeritus scientist **Frank Manheim** gave four lectures at the National University of Ireland (NUI), Galway, and the Geological Survey of Ireland (GSI) in Dublin from March 23 through 27, and a lecture at the University of Stockholm on April 5. The topics were:

- Atlantic margin sediment data base,
- Delmarva resistivity and ground-water studies,
- Lower Mississippi River contaminant studies, and
- Historical survey of the effectiveness of national technologies (United States, Britain, France, Germany, and Russia).

Frank was accompanied by his wife,

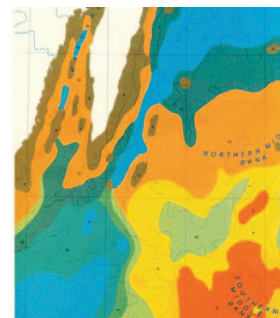


USGS geologist **Lucy McCartan** (Reston, VA). The visit was partly supported by a grant from NUI to **Chaosheng Zhang**, of NUI's Department of Geography, and **Frank Manheim**. **Dr. Zhang** visited USGS headquarters in Reston, VA, in the summer of 2002.

Frank and **Lucy** learned that the Geological Survey of Ireland had received a grant of 32 million euro (equivalent to about US\$ 36 million at press time) to administer a 7-year cooperative survey of Ireland's seabed. Information about the Irish National Seabed Survey is available at URL <http://www.gsiseabed.ie/>. Reaching more than 600 mi out into the Atlantic Ocean, Ireland's territorial seabed encompasses about 10 times the land area of the Republic of Ireland. Both the geological surveys of Ireland and Sweden are involved with a European Union project to create a metadata base for offshore sediment.

A visit to the Swedish Geological Survey (SGU) headquarters in Uppsala revealed that, after retrenchment in earlier years, the SGU has

Limestone Cliffs of Moher on the Irish west coast. Arrows point to medieval castle and people on shelf of rock. No fences prevent people from demonstrating their fearlessness by approaching the edge.



Extract from "Bottom Sediment Map of the Central Baltic Sea: 1:500,000, Lithuanian Swedish Programme, 2001," edited by M. Repecka and I. Cato. Orange shades, gravel; yellow, sand; green and blue, finer sediment and sediment outcrop; white, land (Swedish mainland and Öland).

increased its staff to serve new land and marine programs. New land programs include expanding medical-geology studies and taking control of large caverns earlier dug in bedrock to contain nuclear waste (but never used). SGU's marine program, headed by **Ingemar Cato**, is conducting systematic sidescan-sonar, subbottom-profiling, and swath-bathymetric studies of Swedish national waters under the sponsorship of the Swedish Navy. New maps of bathymetry and sediment texture in the Baltic Sea have been released.

A difference in policy between U.S. and northern European geological surveys (Britain, Sweden, Finland) is that the latter are required to sell rather than freely distribute the results of gridded geochemical surveys and other systematic mapping data. ❁

Meetings

Second International Conference on Saltwater Intrusion and Coastal Aquifers Held on Mexico's Yucatán Peninsula

By Peter Swarzenski

It has been 2 years since the highly successful first International Conference on Saltwater Intrusion and Coastal Aquifers (SWICA1) was held in Essaouira, Morocco. Meanwhile, **Dr. Luis Marin** (Universidad Nacional Autónoma de México) and his band of energetic students, in collaboration with U.S. Geological Survey (USGS) scientists and many other partners, hosted the Second International Conference on Saltwater Intrusion and Coastal

Aquifers (SWICA2) from March 30 to April 2 in Mérida, Mexico. In attendance were nearly 100 scientists from around the world. For a full schedule and additional conference information, please visit URL <http://www.igeofcu.unam.mx/swica2/>.

USGS scientists **Peter Swarzenski** and **Jack Kindinger** (Geology Discipline [GD], St. Petersburg, FL) were asked to join the international steering committee of SWICA in Essaouira and participated

in discussions and planning meetings for future SWICA events and publication venues. Both were also asked to chair sessions in Mérida and have been asked to serve as advisors in a joint Mexico-U.S. National Academy of Sciences venture that will seek collaborative research opportunities in hydrogeology and coastal aquifers.

During the SWICA2 inauguration ceremony, the famous Yucatecan scientist
(Saltwater Intrusion continued on page 11)

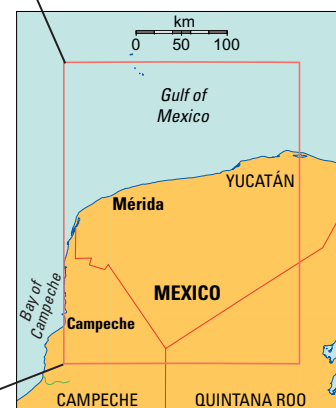
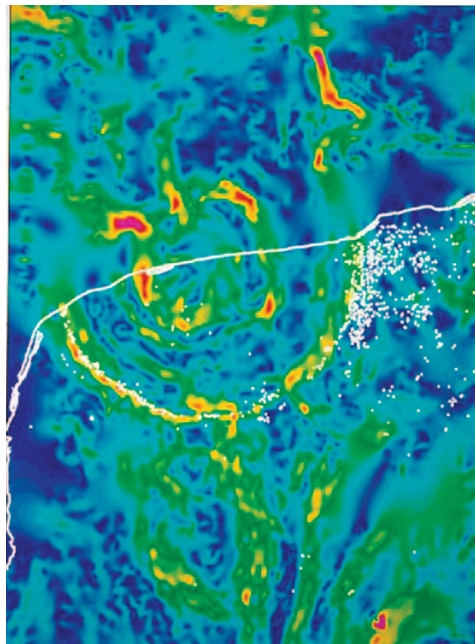
(Saltwater Intrusion continued from page 10)

Antonio Camargo Zanoguera was formally recognized by the Mexican National Academy of Sciences and by other distinguished representatives from Yucatán for his discovery of the Chicxulub impact crater. Chicxulub is a site in northern Yucatán where a giant asteroid or comet struck the Earth approximately 65 million years ago and possibly caused the mass extinctions of the dinosaurs and more than 70 percent of all life on Earth.

Brian Edwards (GD, Menlo Park, CA), **Steve Gingerich** (Water-Resources Discipline [WRD], Honolulu, HI), **Jack Kindinger**, **Kevin Cunningham** (WRD, Miami, FL), **Leonard Konikow** (WRD, Reston, VA), **Christian Langevin** (WRD, Miami, FL), **Dorothy Payne** (WRD, Atlanta, GA), **Peter Swarzenski**, and **Clifford Voss** (WRD, Reston, VA) made USGS presentations at the conference. Speakers from the USGS' Coastal and Marine Geology Program provided clear evidence for the importance of using geologic information to strengthen interdisciplinary hydrogeologic studies and to describe subsurface aquifers and flow systems more realistically. **Brian** provided a refined stratigraphic depiction of the complex Los Angeles Basin coastal-aquifer systems. **Jack** presented new geophysical results from the Lake Belt area of Miami, and **Peter** was asked to present a plenary talk on the geology and hydrogeology of the Florida peninsula.

The conference was a direct result of an ever-increasing proportion of the world's population (now about 70 percent) residing along coastal zones. In response to population and economic growth, ground water

The SWICA2 meeting site, Mérida, Mexico, on the Yucatán Peninsula, lies within the area of the buried Chicxulub impact crater. Evidence for the crater can be seen in this horizontal gradient map of the Bouguer gravity anomaly over the crater. The coastline is shown as a white line. A striking series of concentric features reveals the location of the crater. White dots represent water-filled sinkholes (solution-collapse features common in the limestone rocks of the region) called cenotes after the Maya word *dzonot*. A dramatic ring of cenotes is associated with the largest peripheral gravity-gradient feature. The origin of the cenote ring remains uncertain, although the link to the underlying buried crater seems clear. (Gravity map and explanatory text adapted from Web page at URL <http://miac.uqac.ca/MIAC/chicxulub.htm>.)



is becoming an increasingly important component of overall water demand. The inadequacy of sound management schemes has led to over-exploitation of ground water in many coastal regions of the world, resulting in encroachment of saltwater into coastal aquifers.

The conference objectives were to bring together scientists and water-resources managers from all over the world to exchange state-of-the-art knowledge and to discuss new technological advancements. The conference was a successful multi-

disciplinary meeting of hydrogeologists, geophysicists, geochemists, numerical modelers, managers, and policymakers. The conference theme was to promote an integrated approach that incorporates all aspects of monitoring, modeling, and management in addressing coastal-aquifer issues. Before the conference, well-attended workshops led by **Cliff Voss** and **Lenny Konikow** (USGS) provided hands-on training in the principles and applications of subsurface hydrogeology and numerical modeling. ☼

Gas Hydrates CODATA Meeting

By Bill Winters

The Committee on Data for Science and Technology (CODATA) Task Group on Gas Hydrates Data met in Paris on April 4-5 to discuss plans for conducting regional workshops and to evaluate the content of specific gas-hydrate-related topics. U.S. Geological Survey (USGS) scientist **Bill Winters** (Woods Hole Field Center) presented a template for documenting the occurrence and properties of natural and synthetic gas hydrates.

CODATA is a Paris-based international organization, formed more than 30 years ago to promote the collection, management, manipulation, access to, and understanding of data sets in science and technology. Its 21 international committees are dedicated to the principle that science and technology contain common features which can and must be shared by everyone, and they work to improve the quality and reliability of those data sets.

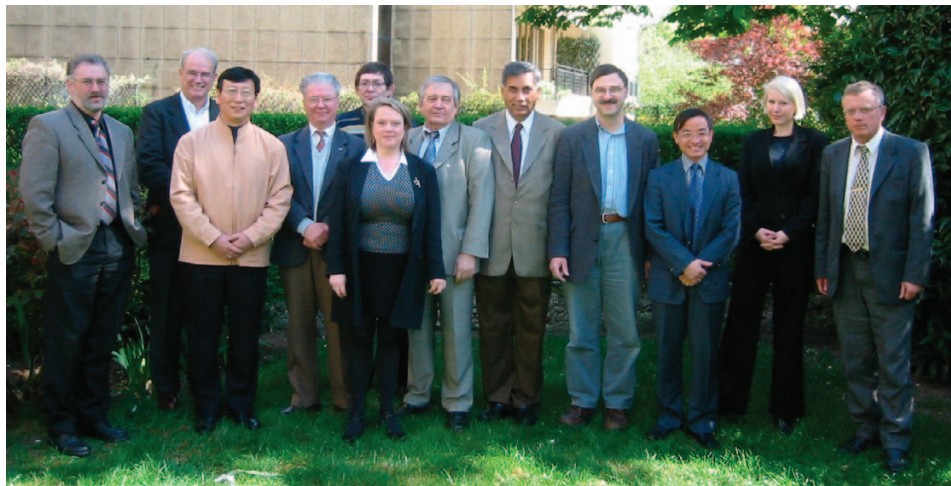
Kathleen Cass is the Executive Director of CODATA. The Gas Hydrate Task Group is chaired by **Fedor Kuznetsov** (Institute of Inorganic Chemistry, Novosibirsk, Russia). Representatives from Canada (**John Ripmeester**, National Research Council, Ottawa), China, France, India, Russia, and the United States (**Dendy Sloan**, Colorado School of Mines, and **Yuri Makogon**, Texas A&M University) attended the gas-

(Gas Hydrates continued on page 12)

(Gas Hydrates continued from page 11)

hydrate planning session. The regional Canadian-U.S. CODATA meeting will be held May 13 during the national American Association of Petroleum Geologists (AAPG) convention in Salt Lake City.

Bill also presented an invited talk about gas hydrates at the Université des Sciences et Technologies de Lille (USTL). Potential future collaborations were discussed with **Viviane Bout-Roumazeilles** and **Alain Trentesaux** (USTL) and **Laurent Labeyrie** (Laboratoire des Sciences du Climat et de l'Environnement, Gif-sur-Yvette), principals on a joint French Polar Institute-USGS giant piston-coring cruise conducted during July 2002 (see September 2002 *Sound Waves*). **Tom Lorenson** (USGS, Menlo Park, CA) and **Charlie Paull** (Monterey Bay Aquarium Research Institute) were also principal investiga-



Members of the CODATA Task Group on Gas Hydrates take a break from their deliberations about creating a worldwide data base on gas-hydrate occurrence and properties.

tors on that U.S. Department of Energy (DOE)-funded cruise to study the potential

distribution of gas hydrates in the Gulf of Mexico. ☼

USGS Conference “Natural Science and Public Health—Prescription for a Better Environment”

By Christina Kellogg

The U.S. Geological Survey (USGS)'s Strategic Plan (1996-2005) described “environmental effects on human health” as a potential growth area for USGS multidisciplinary expertise. In an effort to showcase projects at the intersection of environmental research and human health, the USGS hosted a 3-day conference at the agency's headquarters in Reston, VA, from April 1 to 3. The ultimate goal of the conference was to foster linkages between natural-resource science and human health by bringing together the USGS and its partners in a forum that highlighted the spectrum of contributions USGS research makes to human-health issues.

Cosponsors included the U.S. Environmental Protection Agency, the Armed Forces Institute of Pathology, and the George Washington University School of Public Health and Health Services.

The meeting brought together approximately 150 members of the medical and public-health community, the military, and researchers from a wide variety of backgrounds. Introductory remarks by **USGS Director Charles “Chip” Groat** were followed by a keynote address by **Congressman Ralph Regula** (R-OH).

Information on the influence of the natural environment on human exposure to pathogens and toxic agents has tremendous value for understanding human-health issues. With a long history of environmental research and monitoring, USGS scientists in geology, geography, environmental toxicology and biology, water quality, and other natural sciences have applied their scientific information on geologic-,

atmospheric-, water-, and vector-borne threats to issues related to human health and the health of ecosystems. Many USGS scientists have long been involved in cooperative projects to study the links between environmental factors and human health, including:

- Drinking-water issues
- Atmospheric transport of dust and gases
- Soils
- Mineral reactions
- Wildlife disease
- Remote-sensing and geographic-information-system (GIS) applications

In partnership with public-health professionals, geoscientists are beginning to understand the role of Earth materials and systems in the spread of infectious diseases, such as Lyme disease and West Nile virus fever. Analytical characterization of naturally occurring trace elements and toxic organic compounds in ground water is helping to explain patterns of such diseases as arsenosis and fluorosis in China, and Balkan endemic nephropathy—a condition leading to end-stage

(Environment continued on page 13)



Conference location at USGS headquarters in Reston, VA.

Meetings, continued

(Environment continued from page 12)

kidney failure. Satellites are being used to monitor the movement of huge dust clouds moving across oceans that carry pathogenic microbes, kill coral, and may cause asthma. Rapid-response teams are able to help characterize urban hazards, such as the dust debris from the World Trade Center collapse.

More information about the conference is available on the Web site at URL <http://health.usgs.gov/health2003.html>. Abstracts from research presented at the conference have been collected into USGS Open-File Report 03-097. For a copy of this report, please contact Carolyn Lumb (clumb@usgs.gov).✱



USGS Natural Science and Public Health conference logo.

Staff and Center News

New Chief Scientist for Western Region Coastal and Marine Geology Team to Arrive in Summer

Samuel Y. Johnson was chosen as the next chief scientist for the U.S. Geological Survey (USGS)'s Coastal and Marine Geology (CMG) team in the Western Region. Currently working with the USGS' Central Geologic Hazards team in Denver, CO, **Sam** and his family will move this summer to California, where he will become the first CMG chief scientist to be stationed at the USGS Pacific Science Center in Santa Cruz, CA.

In mid-April, **Sam** paid his first official visit to the team, holding all-hands and one-on-one meetings with team members in Menlo Park and Santa Cruz. **Sam** was enthusiastic about the Coastal and Marine Geology Program, which, as he pointed out, has unique opportunities to integrate scientific research in a broad range of specialties. As he put it, "we are the one USGS program positioned to do anything." His

friendliness and energy inspired team members, who look forward to working with him to advance the team's scientific activities in the regional and national arenas.

While he is in Denver, **Sam** will stay in contact with team and program members, taking part in the FY04 proposal process, for example. We look forward to his arrival in California in August.✱

USGS Mendenhall Fellows Give Lectures in Reston, VA

By Christina Kellogg

Since its inception in 2001, the U.S. Geological Survey (USGS)'s Mendenhall Postdoctoral Research Fellowship Program has been an avenue for bringing young scientists with new talents and skills into the Geologic Discipline of the USGS. Named in honor of **Walter Mendenhall**, the fifth director of the USGS, this program is now moving into its fourth year.

Three of the first-year Mendenhall Fellows, **Thomas L. Ziegler** (Denver, CO), **Christina A. Kellogg** (St. Petersburg, FL), and **Joseph E. Bunnell** (Reston, VA), gave talks during the USGS Conference "Natural Science and Public Health—Prescription for a Better Environment" held in Reston from April 1 to 3. The meeting, which focused on the intersection of environmental research and human health, was a perfect showcase for their research.

While all three Mendenhall Fellows work in the Geologic Discipline, not one is a geologist! **Thomas** is a toxicologist by

training, **Chris** is a molecular microbiologist, and **Joe** is a public-health biologist.

Joe presented his research first, in a talk titled "Environmental Predictors for Tick-Borne Disease Risk in the Middle Atlantic Region, USA." Lyme disease, the most common vector-borne disease in the United States, and ehrlichiosis, an

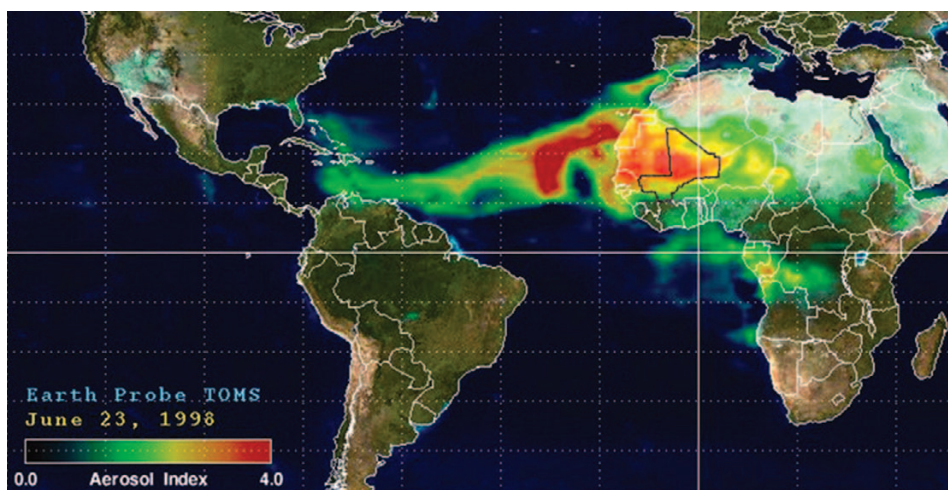


Ticks spread bacterial infections that can be deadly to humans.

emerging deadly disease, are both bacterial infections that are spread by ticks. In an effort to better quantify the risk factors associated with certain areas, a spatial statistical model incorporating such factors as elevation, soil type and features (texture, water-holding capacity), land cover, and proximity to forests or water bodies was used to predict areas most supportive to tick populations. The predictions from this model can help target more effective intervention and, it is hoped, reduce the number of cases of tick-borne disease.

Chris discussed the long-distance transport of microbes in dust from the Sahara/Sahel region of Africa in her presentation titled "Out of Africa: Characterization of Microbial Communities Associated with Desert Dust and Their Implications for Human and Ecosystem Health." Each year, millions of tons of desert soil dust blow off the west African coast and ride the trade winds across the

(Mendenhall continued on page 14)



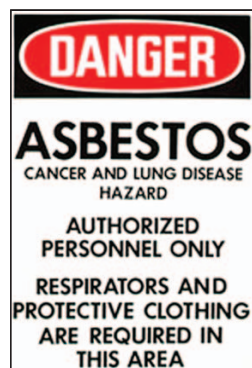
Plume of dust crossing the Atlantic Ocean from Africa to the Caribbean region in June 1998. Image acquired by the National Aeronautics and Space Administration (NASA)'s Earth Probe TOMS (Total Ozone Mapping Spectrometer) satellite.

(Mendenhall continued from page 13)

Atlantic Ocean, routinely affecting the Caribbean and Southeast United States. This dust has been shown to carry living microorganisms, including a wide variety of bacteria and fungi, some of which are capable of causing disease in plants, animals, and humans with weakened immune systems. It is important to characterize and quantify these airborne microbes to assess what effects they may have on downwind ecosystems.

Asbestos is a general term for a group of fibrous silicate minerals used in many construction materials because of their fire-resistant nature. Asbestos can be di-

vided into two mineral groups, serpentine and amphibole, based on the crystalline structure. Serpentine have a sheet or layered structure, whereas amphiboles have a chainlike structure. In spite of its many applications, use of asbestos has declined because of links between asbestos and diseases, including lung cancer. In his talk titled "Mineralogical,



Geochemical, and Toxicological Variations of Asbestos Toxicological Standards and Amphibole Samples from Libby, MT," **Thomas** described how asbestos standards are not as uniform as one would expect. In fact, the chemical analyses of a series of asbestos standards (amosites, anthophyllites, chrysotiles, crocidolites, and tremolites) indicated that elemental content varied within standards of the same mineral. Furthermore, each asbestos mineral, even those labeled as the same mineral, has its own profile of accessory minerals, which may play a role in the wide range of toxicity seen in the cell-line toxicity data presented and may possibly explain some of the conflicting reports for asbestos toxicity found in the literature. In addition, toxicity data were presented for the Libby, MT, amphibole that was revealed to be significantly more toxic than the asbestos standards.

In addition to the 20-minute talks given during the conference, both of the "out-of-towners" gave hour-long lectures about their Mendenhall research in the USGS Visitors Center: **Thomas** spoke the Monday before the conference, and **Chris** followed on the Friday after.

For more information on the Mendenhall program, including profiles of the Fellows and their research projects, please visit the Web site at URL <http://geology.usgs.gov/postdoc/> or contact Rama Kotra (rkotra@usgs.gov). ☼

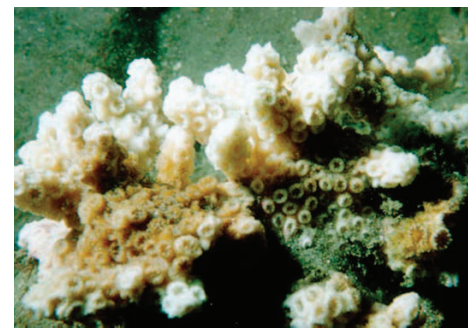
Mendenhall Postdoctoral Fellow Joins Coral Reef Project

By Mike Field

Greg Piniak, a new U.S. Geological Survey (USGS) Mendenhall Postdoctoral Fellow, arrived at the USGS Pacific Science Center in Santa Cruz, CA, on March 31 to begin his fellowship. **Greg** is a recent Ph.D. graduate in ecology from Duke University, where he wrote his dissertation on the physiology of coral feeding. For the past year, **Greg** has been a postdoctoral fellow at the National Oceanic and Atmospheric Administration (NOAA)'s Center for Coastal Fisheries and Habitat Research in Beaufort, NC, conducting benthic-habitat and coral-recruitment studies in the Dry Tortugas off

Florida, and modeling studies to predict recovery of coral-reef systems from vessel-grounding injuries.

Greg joins the Coastal and Marine Geology Program's Coral Reef Project to provide expertise on the effects of sediment turbidity on coral productivity. Specifically, **Greg** will be investigating physiological energetics as an indicator of coral-reef health, with a goal of developing a physiological index (scope for growth) as a tool to evaluate the health and performance of coral-reef systems. Studies in the Coral Reef Project and throughout the Coastal and Marine Geol-



Oculina arbuscula is one of the corals **Greg** studied for his Ph.D. dissertation.

ogy Program are increasingly multidisciplinary in scope, and **Greg** will add new breadth to our scientific strengths. ☼

Scientist from the Netherlands Visiting USGS in Woods Hole

Jan Adriaan (“Dano”) Roelvink will be visiting the U.S. Geological Survey (USGS) in Woods Hole, MA, from mid-April through mid-June. **Dano** is a senior engineer at WLDelft Hydraulics Laboratory in The Netherlands and also teaches at the Technical University of Delft. **Dano** is one of the innovative forces behind the Delft3D numerical model for waves, cur-

rents, and morphologic change in coastal systems. His visit continues a cooperative effort between the Coastal and Marine Geology Program (CMGP) and Delft Hydraulics, which has included visits to Delft by CMGP scientists (see April 2002 *Sound Waves*) and visits to the USGS in Menlo Park, CA, by **Mathijs Meijs** and **Giles Lesser** (see February 2002 and November

2002 *Sound Waves*). **Dano** is taking a sabbatical from Delft to write “the book” on coastal modeling, and looks forward to interacting with USGS and Woods Hole Oceanographic Institution scientists during his visit. ☼

USGS Employees Find Avocation in Blacksmithing

By Barbara Lidz

Blacksmithing is more than just a skill; it is an art. **Dana Wiese**, electronics technician at the U.S. Geological Survey (USGS)’s Center for Coastal and Watershed Studies in St. Petersburg, FL, and **Ann Tihansky**, hydrologist at the USGS Water Resources office in Tampa, FL, discovered they were classmates in a blacksmithing course recently held at Ramshead Forge in San Antonio, FL. These are their words.

Dana: “The course covered forge welding, annealing, drawing out, fullering, upsetting, and most aspects of traditional blacksmithing. All levels of blacksmiths attend the course. Today there is a distinction between a farrier (someone who shoes horses) and a blacksmith. Most blacksmiths deal in ornamental, useful ironwork, and some are also farriers. Farriers are not

blacksmiths but deal in the proper care of horses’ hooves and legs. In the past, part of a blacksmith’s work was shoeing horses, as well as making iron tools and fixtures.

“I’ve been interested in blacksmithing for a few years. A while ago, I bought a forge, anvil, basic smithing tools, and joined FABA [Florida Artist Blacksmith Association], then tried to pound out some pieces. The Ramshead Forge seminar was the first real course I’ve taken. **Lewis Riggleman**, a master blacksmith, presented the course. **Lewis** is the owner/artist of Ramshead Forge. Seems like **Ann** and I have had a similar interest in blacksmithing and metal art for some time. I happened to mention to **Ann** that I was taking a blacksmith course this spring, and she mentioned she was also taking one. After a while, we realized we were taking the same course.

“I’m interested in the artistic end of blacksmithing: the idea of taking an unyielding piece of raw steel or iron and, with fire, air, water, and hammerblows, making something artistic and, hopefully, useful. Throughout the ages, people have looked to blacksmiths to provide them with high-quality tools and furnishings for the home, farm, and workplace that would serve them well and brighten their surroundings. I want to carry on this traditional craft, using ancient principles of traditional joinery and forging techniques.

“Neither **Ann** nor I may ever shoe a horse, but we can make horseshoes. I suppose, if we were in the field and someone needed a special tool forged or something bent up, we could do the job. Making an open-end wrench would be easy. Along



Dana bends a piece of metal rod around the horn of the anvil to make a hook.

with that, you’d have the only hand-forged, artistic open-end wrench in the USGS!”

Ann: “**Dana** pretty much summed it up. As a kid, I started doing cutting work with an oxyacetylene torch setup, and I make my own candleholders. This was my first class at building, joining, and constructing metalwork. I have always wanted to take more metalworking classes, such as traditional welding methods, but the blacksmithing class came first.

“Like **Dana**, my desire is to use these techniques for artistic expression and functional artistic items. It’s definitely hard, dirty work, which I seem to like. But if someone told me I had to make 300 nails, I think I would suggest they go to Home Depot!” ☼



Ann holds up her finished projects, a fire poker and pot rack.

Major Hurricanes along the North Gulf Coast of Florida Affect Adult Survival Rates of the Endangered Florida Manatee

By Catherine Langtimm

A paper entitled "Lower survival probabilities for adult Florida manatees in years with intense coastal storms" by **Catherine Langtimm** and **Cathy Beck**, wildlife biologists at the U.S. Geological Survey (USGS)'s Center for Aquatic Resource Studies in Gainesville, FL, was published in the journal *Ecological Applications* in February. Understanding how animal populations respond to hurricanes has generally been limited by a lack of critical prehurricane data necessary to make poststorm comparisons. This study presents the first empirical evidence for the storm effects on manatee-survival rates and was based on 19 years of photo-identification data. Identifying and understanding hurricane effects for this species and others is critical for short- and long-term planning by researchers, managers, and policymakers.

The study identified lower survival rates in 1985 with Hurricanes Elena and Kate, in 1993 with the March "Storm of the Century" that impacted the entire east coast, and in 1995 with Hurricane Opal. These storms were category 3 or greater

on the Saffir-Simpson scale. The decreases in manatee survival could be due to direct mortality, indirect mortality, and (or) emigration from the region as a consequence of storms. Future impacts to the population by a single catastrophic hurricane, or by a series of smaller hurricanes, could increase the probability of manatee extinction. With the advent in 1995 of a new 25- to 50-year cycle of greater hurricane activity and intensity identified by meteorologic researchers, and longer-term change possible with global climate change, the study concludes that it becomes all the more important to reduce manatee mortality and injury from boats and other human causes and to control the loss of foraging habitat to coastal development.

Recent publications on manatees from the Center for Aquatic Resource Studies: Langtimm, C.A., and Beck, C.A., 2003, Lower survival probabilities for adult Florida manatees in years with intense coastal storms: *Ecological Applications*, v. 13, p. 257-268.

Deutsch, C.J., Reid, J.P., Bonde, R.K.,

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Contact with a boat propeller injured this manatee. The healed scar is one of the "naturally occurring" marks used to identify this individual. Annual resightings of uniquely scarred animals provide the data to estimate annual survival rates. Photographs are used to document the sightings and verify identifica-

tions of individuals in the scar-catalog data base. This female, BS107 (a.k.a. "Phyllis"), has been photographed regularly since 1988 and gave birth to twins in 1991.

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(Recently Published continued on page 17)

(Recently Published continued from page 16)

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